Motion correction for free breathing quantitative myocardial t2 mapping: impact on reproducibility and spatial variability

Citation	Roujol, Sébastien, Tamer A Basha, Sebastian Weingartner, Mehmet Akcakaya, Sophie Berg, Warren J Manning, and Reza Nezafat. 2015. "Motion correction for free breathing quantitative myocardial t2 mapping: impact on reproducibility and spatial variability." Journal of Cardiovascular Magnetic Resonance 17 (1): W5. doi:10.1186/1532-429X-17-S1-W5. http://dx.doi.org/10.1186/1532-429X-17-S1-W5.
Published Version	doi:10.1186/1532-429X-17-S1-W5
Citable link	http://nrs.harvard.edu/urn-3:HUL.InstRepos:14065498
Terms of Use	This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA

Roujol et al. Journal of Cardiovascular Magnetic Resonance 2015, 17(Suppl 1):W5
http://www.jcmr-online.com/content/17/S1/W5

Journal of Cardiovascular Magnetic Resonance

WORKSHOP PRESENTATION Open Access

Motion correction for free breathing quantitative myocardial t_2 mapping: impact on reproducibility and spatial variability

Sébastien Roujol[1*], Tamer A Basha[1], Sebastian Weingartner[1,2], Mehmet Akcakaya[1], Sophie Berg[1], Warren J Manning[1,3], Reza Nezafat[1]

From 18th Annual SCMR Scientific Sessions
Nice, France. 4-7 February 2015

Background

Quantitative myocardial T_2 mapping is a promising technique for *in-vivo* assessment of inflammation and edema [1]. Free breathing T_2 mapping sequences increase the flexibility in the choice of the number of T_2prep echoes times (TE_{T2P}), but should be combined with respiratory motion correction technique [2]. In this study, we sought to evaluate the performance of the Adaptive Registration of varying Contrast-weighted images for improved TIssue Characterization (ARCTIC) algorithm [3] for in-plane motion correction in T_2 mapping data and its impact on in-vivo reproducibility and spatial variability of myocardial T_2 estimates.

Methods

Seven healthy adult subjects (30±17y, 3male) were imaged using a 1.5 T Phillips scanner. T_2 mapping was performed using either 1) a "T_{2P}4TE" sequence (4 T_2prep echo times=[0, 25, 50, ∞]), or 2) a "T_{2P}20TE" sequence (20 T_2prep echo times=[0, 25, 30, 35, ..., 95, 100, ∞, ∞, ∞]) [4]. TE_{T2P}=∞ was simulated by acquiring an image immediately after a saturation pulse [4]. Each subject was imaged using eight T_2 mapping scans in the following order: 1) breath-held T_{2P}4TE (BH), 2) free breathing T_{2P}4TE *without* respiratory navigator (FB), 3) free breathing T_{2P}4TE *with* respiratory navigator (FB+NAV), and 4) free breathing T_{2P}20TE *with* respiratory navigator (5 repetitions). The same 2D short axis slice was acquired with all scans using single-shot ECG-triggered acquisitions with balanced SSFP imaging readout ($TR/TE/\alpha$=2.7ms/1.35ms/85°, FOV=240×240mm^2, resolution=2.5×2.5×8mm^3, 10 linear ramp-up pulses, SENSE rate=2, 51 phase encoding lines, linear ordering). Accuracy of in-plane motion correction was evaluated in the first three scans by measurements of the DICE similarity coefficients (DSC) (1: ideal registration, 0: none) and the myocardial boundary error (MBE) with and without using ARCTIC. T_2 mapping reproducibility and spatial variability with and without using ARCTIC was evaluated over the entire myocardium using the 5 repetitions of the T_{2P}20TE sequence and 1) a subset of 4 T_2prep echo times=[0ms, 25ms, 50ms, ∞] (referred to as 4TE) and 2) all 20 T_2prep echo times (referred to as 20TE).

Results

ARCTIC increased DSC in BH data (0.90±0.02 vs. 0.87±0.05, p=0.09), FB data (0.91±0.02 vs. 0.79±0.15, p=0.009), and FB+NAV data (0.90±0.02 vs. 0.86±0.08, p=0.039), and reduced MBE in BH data (0.63±0.09 vs. 0.74±0.12, p=0.049), FB data (0.60±0.12 vs. 1.16±0.71, p=0.007), and FB+NAV data (0.61±0.13 vs. 0.83±0.28, p=0.025). ARCTIC improved the reproducibility (4TE: 5.0±2.3ms vs. 5.9±3.1ms, p=0.011; 20TE: 2.4±1.0ms vs. 4.3±3.9ms, p=0.002) and reduced spatial variability (4TE: 11.1±3.6ms vs. 13.7±4.3ms, p<0.001; 20TE: 7.9±1.8ms vs. 10.6±5.3ms, p=0.001) of in-vivo T_2 mapping.

Conclusions

The ARCTIC technique substantially reduces spatial mis-alignment among T_2-weighted images and improves both the reproducibility and the spatial variability of in-vivo T_2 mapping.

[1]Department of Medicine (Cardiovascular Division), BIDMC / Harvard Medical School, Boston, MA, USA
Full list of author information is available at the end of the article

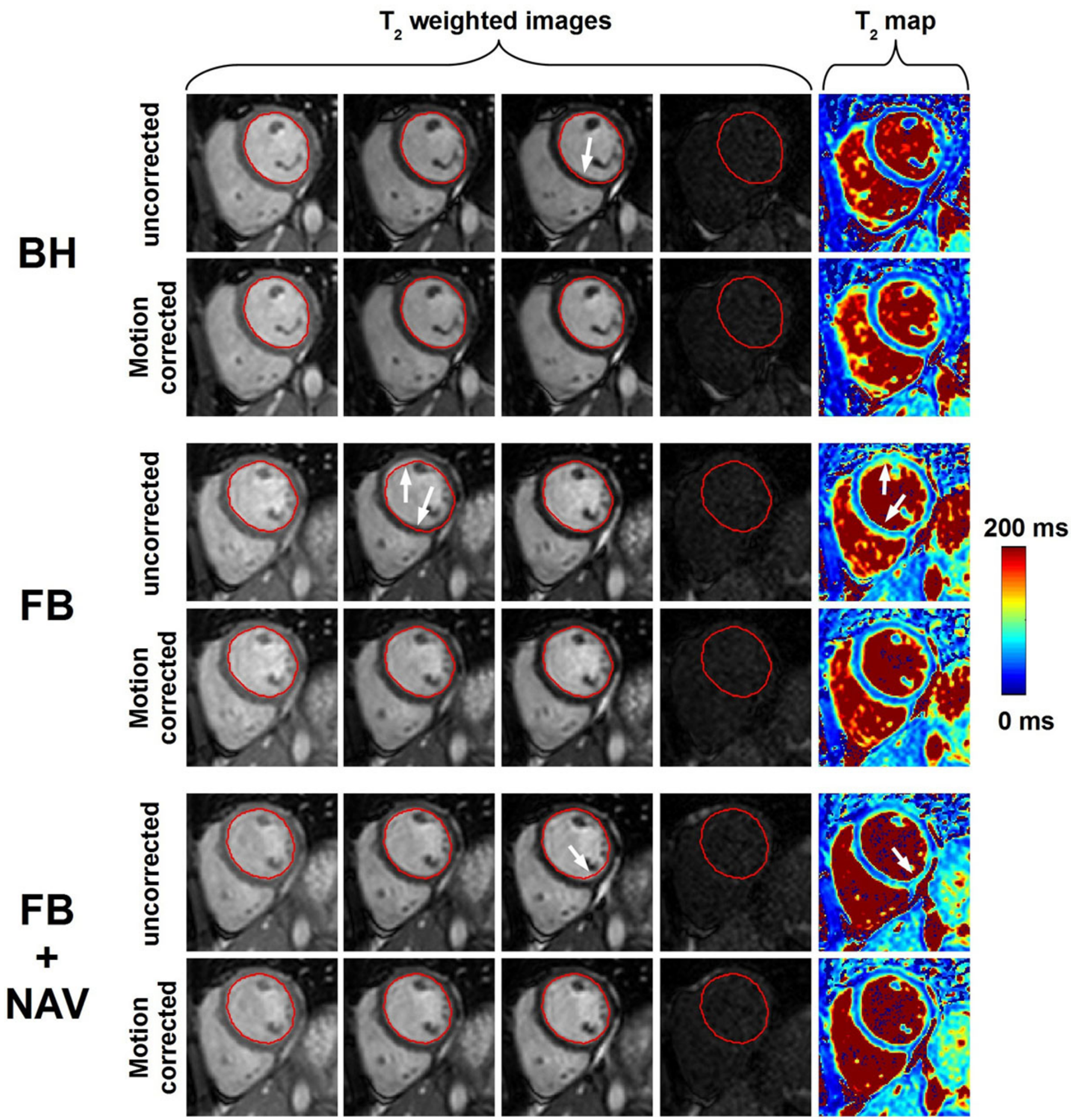

Figure 1 T_2 scans from one subject acquired using the T_{2P}4TE sequence under breath-hold (BH), free breathing (FB), and free breathing with respiratory navigator gating (FB+NAV). Data are shown without (uncorrected) and with (motion corrected) in-plane motion correction. The endocardial contour of the left ventricular (LV) myocardium, drawn on the reference image (1st image) of each scan, is reported in all subsequent T_2-weighted images to facilitate visual motion assessment. Misalignments observed among uncorrected images (white arrows) were substantially reduced after in-plane motion correction using ARCTIC. Furthermore, artifacts in uncorrected T_2 maps (white arrows) were reduced in motion corrected T_2 maps.

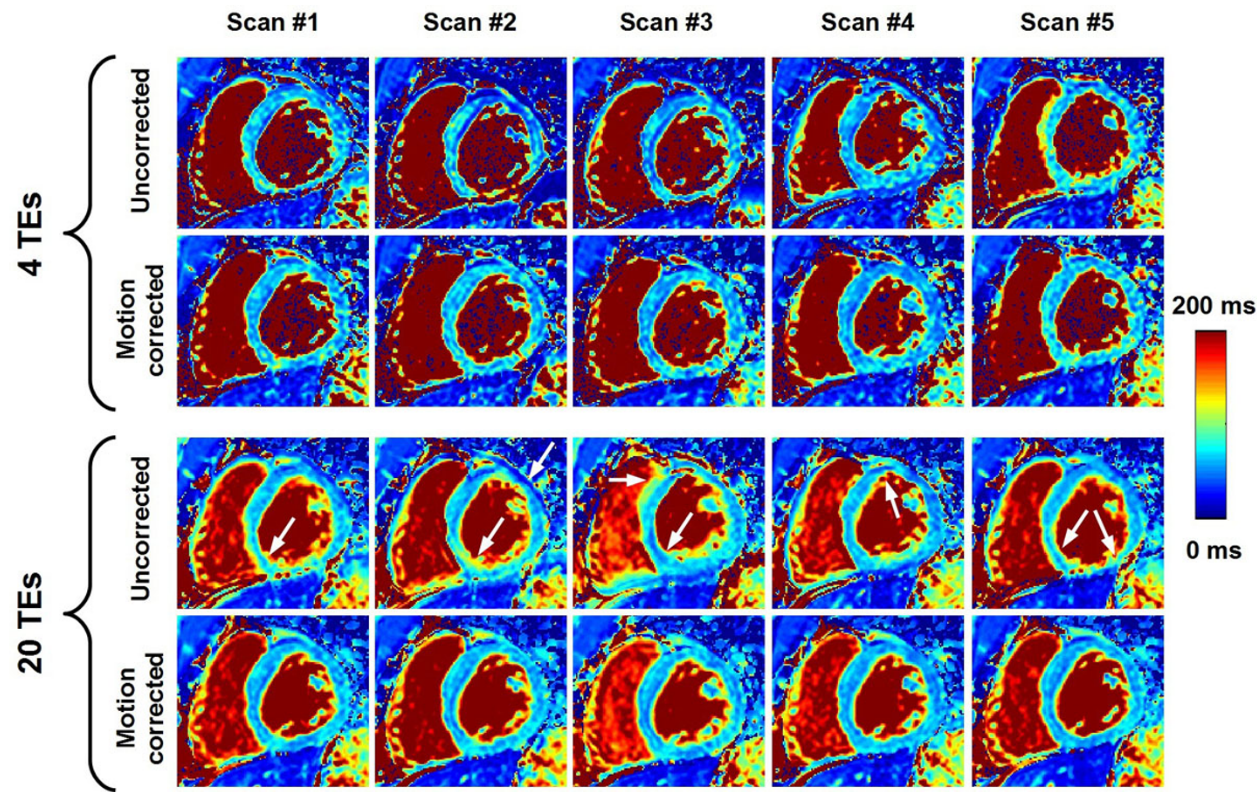

Figure 2 Example of multiple T_2 maps acquired on the same subject using the five repetitions of the T_{2P}20TE sequence acquired under free breathing conditions with respiratory navigator gating. T_2 maps were reconstructed with all T_2prep echo times (20 TEs) or only a subset of the T_2prep echo times (0ms, 25ms, 50ms, ∞) (4 TEs). While the remaining in-plane motion generates artifacts on the directly reconstructed T_2 maps (uncorrected), substantial improvement of T_2 map quality was obtained using in-plane motion correction (motion corrected). As expected, the homogeneity of the T_2 maps greatly improved when using all 20 T_2prep echo times compared to only 4 T_2prep echo times.

Authors' details
[1]Department of Medicine (Cardiovascular Division), BIDMC / Harvard Medical School, Boston, MA, USA. [2]Computer Assisted Clinical Medicine, University Medical Center Mannheim, Heidelberg University, Mannheim, Germany. [3]Radiology, BIDMC / Harvard Medical School, Boston, MA, USA.

Published: 3 February 2015

References

1. McNamara: *Circulation* 1985.
2. Giri: *MRM* 2012.
3. Roujol: *MRM* 2014.
4. Akçakaya: *MRM* 2014.

doi:10.1186/1532-429X-17-S1-W5
Cite this article as: Roujol *et al.*: Motion correction for free breathing quantitative myocardial t_2 mapping: impact on reproducibility and spatial variability. *Journal of Cardiovascular Magnetic Resonance* 2015 **17**(Suppl 1):W5.